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10/066,485	02/01/2002	Kuo-Chuan Liu	6136/53592 (25916-125)	7648

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EXAMINER	
HARAN, JOHN T	

ART UNIT	PAPER NUMBER
1733	

DATE MAILED: 01/09/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/066,485	LIU ET AL.	
	Examiner	Art Unit	
	John T. Haran	1733	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *18 November 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-18* is/are pending in the application.

4a) Of the above claim(s) *4 and 16-18* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-3,5-12 and 15* is/are rejected.

7)☒ Claim(s) *13 and 14* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. §§ 119 and 120

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

13)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

a) ☐ The translation of the foreign language provisional application has been received.

14)☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____.
4) ☐ Interview Summary (PTO-413) Paper No(s). _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

Election/Restrictions

1. Applicant's election with traverse of claims 1-3 and 5-15 in the response filed on 11/18/03 is acknowledged. The traversal is on the ground(s) that the product claim specifically requires a transformation of the bonding layer from a bonding layer precursor and saying that the product can be made by a process that does not involve transforming the thin bonding layer is not a proper showing of distinctness. Regardless, this is not found persuasive because applicant did not address the other reasoning provided in the restriction requirement that the product could be made by a process that uses a material other than metal for the bonding layer such as adhesive.

Applicant additionally argued the species restriction. It is noted that the species restriction is valid because the bonding layer is either deposited on the post or the structure and the two methods are mutually exclusive. Applicant's statement that it is not material to the invention whether the bonding layer is applied to the post or conducting structure is noted. **Rejoinder of the species claims will be considered upon the indication of allowable subject matter and the basis thereof.**

2. The requirement is still deemed proper and is therefore made **FINAL**.

Information Disclosure Statement

3. The listing of references in the specification is not a proper information disclosure statement. 37 CFR 1.98(b) requires a list of all patents, publications, or other information submitted for consideration by the Office, and MPEP § 609 A(1) states, "the

list may not be incorporated into the specification but must be submitted in a separate paper." Therefore, unless the references have been cited by the examiner on form PTO-892, they have not been considered.

Claim Rejections - 35 USC § 112

4. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5. Claims 1-3 and 5-15 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claims 1 and 5 are indefinite because the claims indicates that the compressing and transforming are two separate steps, however the specification (page 48, last paragraph) appears to indicate that the compression in conjunction with heating causes the transformation and is one single step. It is suggested to amend the claims to indicate that the thin layer of metal is compressed and heated thereby transforming it into a bonding layer.

Additionally in claim 5, it is unclear if the pressing and compressing steps are two separate steps or the same step. It appears that the spreading of the underfill and the transformation of the metal layer occur at the same time and it is suggested to amend the claim to indicate the first and second substrates are compressed and heated to thereby cause the liquid polymeric material to flow towards the edges and to thereby transform the thin metal layer into a bonding layer.

Additionally it is noted that the specification uses the claim terminology in the summary of the invention (page 6) but uses different terminology in the detailed description of the preferred embodiments of the invention (pages 48-50) referring to the bonding layer as an intermetallic layer or high melting point phase or layer instead of as the bonding layer. The terminology utilized should be consistent throughout the claims and specification to avoid confusion.

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

7. Claims 1-3 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tung (U.S. Patent 6,578,754) in view of Gallagher et al (U.S. Patent 5,948,533) and Iino et al (U.S. Patent 6,207,259).

Tung et al is directed to a method for forming flip chip interconnects wherein copper pillars (posts) are formed on the contact pads of a substrate and a lead/tin based solder (thin layer of metal) is applied to the end of the pillar, the flip chip is bonded to a substrate under heat and pressure wherein the solder on the copper pillars is bonded to the contact sites on the flip chip and a dielectric underfill is applied (Column 4, lines 23-40; Column 5, lines 25-30; Figures 3B and 3C). Tung et al are

silent towards transforming the solder (metal layer) into a bonding layer that has a higher melting temperature than the melting temperature of the solder (metal layer).

It is well known and conventional that when solder containing tin is in contact with copper and compressed and heated the tin in the solder and the copper react to form an intermetallic region (i.e. transform the solder (metal)), as shown for example in Gallagher et al (Column 6, lines 45-60; Column 7, lines 31-32; and Column 9, lines 5-10) and Iino et al (Column 3, lines 63-65 and Column 6, lines 30-50). Furthermore, Gallagher teaches that such an intermetallic region has a higher melting temperature than the solder and is beneficial because the region is less likely to remelt in subsequent processing steps as a result of the high melting temperature (Column 9, lines 5-17). One skilled in the art would have readily appreciated that the lamination step of Tung et al would produce an intermetallic region from the tin in the solder and the copper in the pillars, thereby transforming the solder into a intermetallic bonding layer that has a higher melting temperature than the solder. It would have been obvious to one of ordinary skill in the art at the time the invention was made that the lamination of the flip chip to the substrate in the method of Tung et al would result in the tin in the solder and the copper in the pillars reacting to transform the solder (thin metal layer) into an intermetallic bonding layer as taught in Gallagher and Iino and to ensure adequate heat and pressure is applied so that the intermetallic bonding layer has a higher melting temperature than the solder (metal layer) in order to provide greater stability for the bond in subsequent processing as suggested in Gallagher.

Regarding claim 2, Tung et al teach depositing a dielectric underfill (18) around the conductive posts (See Figure 3B).

Regarding claim 3, Tung et al teaches using a Sn/Pb solder or any other type of solder (Column 5, lines 58-60). It is well known and conventional to have solder comprising In, Sn, Bi or mixtures thereof, as shown for example in Gallagher et al (Column 6, lines 44-46) and it would have been obvious to use any of them in the method of Tung et al, as modified above.

8. Claims 5-6 rejected under 35 U.S.C. 103(a) as being unpatentable over Tung (U.S. Patent 6,578,754) in view of Murakami (U.S. Patent 6,133,066) and taken with Gallagher et al (U.S. Patent 5,948,533) and Iino et al (U.S. Patent 6,207,259).

Tung et al is directed to a method for forming flip chip interconnects wherein copper pillars (posts) are formed on the contact pads of a substrate and a lead/tin based solder (thin layer of metal) is applied to the end of the pillar, a flip chip is bonded to a substrate under heat and pressure wherein the solder on the copper pillars is bonded to the contact sites on the flip chip and a dielectric underfill is injected between the chip and substrate (Column 4, lines 23-40; Column 5, lines 25-30; Figures 3B and 3C). Tung et al are silent towards dispensing the underfill between the chip and substrate so that it is disposed inwardly from the edges of the chip and substrate and pressing the chip and substrate together to cause the underfill to flow towards the edges of the chip and the substrate.

One skilled in the art would have readily appreciated that there are numerous alternate expedients for forming a dielectric underfill layer between two components with interconnects. For example, the underfill can be injected between two surfaces as taught in Tung et al, or the liquid dielectric underfill can be dispensed between the two surfaces inward for the edges and then the surfaces are pressed together to cause the underfill to flow towards the edges of the surface as taught in Murakami (See Figures 3G-H). One skilled in the art would have readily appreciated that these are alternate expedients for having a dielectric underfill layer between the substrates and around conductive posts that are obvious one over the other and that only the expected results would be achieved. It would have been obvious to one of ordinary skill in the art at the time the invention was made to dispense the underfill between the chip and substrate so that it is disposed inwardly from the edges of the chip and substrate and then press the chip and substrate together to cause the underfill to flow towards the edges of the chip and the substrate in the method of Tung et al, as suggested in Murakami.

It is also noted that Tung et al teaches place the solder layer on the copper pillar and is silent towards placing it on the conductive contact sites of the flip chip. One of ordinary skill in the art would have readily appreciated that the solder layer needs to be placed on either the copper pillar or the conductive contact sites and that the two are alternate expedients obvious over one another. It would have been obvious to one of ordinary skill in the art at the time the invention was made to place the solder layer (thin metal layer) on the conductive contact sites of the flip chip in the method of the Tung et al, as modified above.

Tung et al are silent towards transforming the solder (metal layer) into a bonding layer that has a higher melting temperature than the melting temperature of the solder (metal layer). It is well known and conventional that when solder containing tin is in contact with copper and compressed and heated the tin in the solder and the copper react to form an intermetallic region (i.e. transform the solder (metal)), as shown for example in Gallagher et al (Column 6, lines 45-60; Column 7, lines 31-32; and Column 9, lines 5-10) and Iino et al (Column 3, lines 63-65 and Column 6, lines 30-50). Furthermore, Gallagher teaches that such an intermetallic region has a higher melting temperature than the solder and is beneficial because the region is less likely to remelt in subsequent processing steps as a result of the high melting temperature (Column 9, lines 5-17). One skilled in the art would have readily appreciated that the lamination step of Tung et al would produce an intermetallic region from the tin in the solder and the copper pillars, thereby transforming the solder into a intermetallic bonding layer that has a higher melting temperature than the solder. It would have been obvious to one of ordinary skill in the art at the time the invention was made that the lamination of the flip chip to the substrate in the method of Tung et al, as modified above, would result in the tin in the solder and the copper in the pillars reacting to transform the solder (thin metal layer) into an intermetallic bonding layer as taught in Gallagher and Iino and to ensure adequate heat and pressure is applied so that the intermetallic bonding layer has a higher melting temperature than the solder (metal layer) in order to provide greater stability for the bond in subsequent processing as suggested in Gallagher.

Regarding claim 6, Tung et al are silent towards curing the underfill however, such is well known and conventional, as shown for example in Murakami (Column 4, lines 55-61) and it would have been obvious to do so in the method of Tung et al, as modified above in order to solidify the underfill.

9. Claims 7-8 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tung (U.S. Patent 6,578,754) in view of Murakami (U.S. Patent 6,133,066) and taken with Gallagher et al (U.S. Patent 5,948,533) and Iino et al (U.S. Patent 6,207,259) as applied to claims 5-6 above, and further in view of Wang (U.S. Patent 6,467,676).

Tung et al is silent towards the underfill sealing resin containing a polymer fluxing agent. It is well known and conventional for underfill sealing resins to contain polymer fluxing agents and for the underfill material to comprise from about 15% by weight to 70% by weight of a polymeric resin, about 15% to 70% by weight of a curing agent, and from 0.10% to 20% by weight of fluxing agent, as shown for example in Wang (See Examples). It would have been obvious to one of ordinary skill in the art at the time the invention was made to use well known and conventional underfill resin in the method of Tung et al, as modified above.

10. Claims 9-12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tung (U.S. Patent 6,578,754) in view of Murakami (U.S. Patent 6,133,066) and taken with Gallagher et al (U.S. Patent 5,948,533) and Iino et al (U.S. Patent 6,207,259) as

applied to claims 5-6 above, and further in view of Wang (U.S. Patent 6,467,676) as applied to claims 7-8 above, and further in view of Stefanowski (U.S. Patent 5,334,260).

Regarding claims 9-12, it is well known and conventional to use phenylacids such as phenylacetic acid in fluxing agents, as shown for example in Stefanowski (Column 3, lines 20-28). It would have been obvious to one of ordinary skill in the art at the time the invention was made to use well known and conventional fluxing agents in the method of Tung et al, as modified above.

Allowable Subject Matter

11. Claims 13 and 14 objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

12. The following is a statement of reasons for the indication of allowable subject matter:

The prior art fails to suggest a fluxing agent comprising a beta phenylacrylic acid and a beta phenylhydroxyacrylic acid. Absent any art showing a fluxing agent comprising both types of acid the subject matter of claims 13 and 14 is considered allowable.

Conclusion

13. Any inquiry concerning this communication or earlier communications from the examiner should be directed to **John T. Haran** whose telephone number is **(571) 272-1217**. The examiner can normally be reached on M-Th (8 - 5) and alternate Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Richard Crispino can be reached on (571) 272-1226. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0661.

John T. Haran
Examiner
Art Unit 1733